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OIL AND NATURAL GAS DEVELOPMENT IN THE PROVINCE OF THE REPUBLIC OF CHINA

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OIL AND NATURAL GAS DEVELOPMENT IN THE PROVINCE OF

THE REPUBLIC OF CHINA

by

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Geological Setting

1. The island of Taiwan is separated by a distance of 150 miles from the eastern coast of China mainland by the Taiwan strait. With the structural relationship of Taiwan to the neighboring island, Ryukyu at the north, Philippines at the south, it becomes an important link of the island arc chain around the border of the western Pacific.

2. Taiwan is a spindle-shaped island with its axis running NNE-SSW. Along the axis of Taiwan, lies a prominent central mountain range, 3,500 meters above the sea level, as the main water divide of the Island. The western slope of the central mountain range comprises the foothill belt table-land and the coastal plain near the Taiwan strait is comparatively wider and topographically gentler than the area of the eastern slope as well as the eastern coastal range bordering the eastern coast to the Pacific.

3. The central mountain range could be considered as an isolated block separated by two major longitudinal faults at both sides. It is constituted chiefly by the metamorphic Paleozoic, Mesozoic and the early Tertiary rocks. The pre-Tertiary is a highly complex series consisting of paragneiss, chlorite schist, marble etc. whereas the early Tertiary comprises Eocene, Oligocene slate and quartzite which were not so much altered as the pre-Tertiary.

Because of the intense complexity of the structure in the metamorphic zone, the chance of petroleum preservation seems not very favourable.

4. To the west of the major fault bordering the western slope of the central mountain range, the area running N-S includes the outcropped younger Tertiary belt of the foothills and the covered area of the low land. The whole western part of Taiwan forms a most important sedimentary basin to be explored for its oil potentialities. It is known from geological and geophysical studies that the major marine deposits of the Miocene, Pliocene and Pleistocene constitute a sedimentary pile thickened toward the eastern margin to about 8,000 meters and progressively thinning toward west. The genesis of the sedimentary wedge was probably due chiefly to continuous sinking of the eastern side of the geosyncline.

It is also characteristic in the geosynclinal deposits that in the north western part of Taiwan, shallow marine sediments are predominant whereas towards south, the open marginal sea deposits developed.

5. Uncertainty about the petroleum bearing rocks of Taiwan remains The major production is in the late Cenozoic sequence, oil and natural gas have been found mainly from the Miocene formation. In northern Taiwan, because the Miocene were deposited under the shallow marine environment, the reservoirs usually are clean and porous in the quartzose sand, and in the Post-Miocene formation in this region, no oil or gas has yet been found. In the southern region, the sediments become muddy and little oil is produced from the Miocene and some dissolved gas in the connate water has been found in the Pliocene formation.

6. The structure of the geosynclinal sediments is disturbed more strongly to the east near the major fault of the central mountain range, folding and faulting are displayed along the inner foothills belt. Structural deformations towards west near the Taiwan Strait.

7. The earlier exploratory drillings were mostly undertaken in the structure with Pliocene or Miocene formation outcrops at the surface and the results were very promising because of the structural complexity. Recently deep drilling has taken place in the gentle anticline, Chinshui, in the north part of Taiwan. Successful results of producing substantial amounts of natural gas in the deeper Miocene formation leads to hope that the petroleum potentiality will be promising if deeper drilling is carried out in the whole Miocene sequence in the gentle fold belt of western Taiwan.

8. Up to now, about sixty structures of interest for petrol research have been found in this Island, several of them already tested to shallow depth but the evaluation of their potentialities should be judged with the present new justification. Further exploration work should be carried out to the more structurally complex area of the eastern coastal range as well as the southern tip of Taiwan, where the oil possibilities in the Neogene sequence still exist but would wait until the exploration work of the sedimentary basin in the western Taiwan has reached a more advanced stage.

9. Petroleum and natural gas were incidentally discovered in Taiwan as early as 1817 in the vicinity of Chuhuangkeng, the present oil producing field in northern Taiwan. In 1861 the government of the Ching Dynasty started to explore oil resources by a very primitive method. No substantial result was achieved. Rather extensive petroleum exploration began in 1895. During the last half century seven meagre producing fields were discovered, some of them did not last very long. During the World War II the exploration and development of petroleum were inactive, only keeping the old fields in production at a declining rate each year. Since 1946 the geological field mapping and gravity meter survey has been conducted by Chinese Petroleum Corporation (CPC) at reconnaissance scale. Gravimetric survey has been carried out for about one year starting from 1946. The seismic reflection was introduced in Taiwan in 1955. At the beginning, one seismic party was organized with a Chinese crew and supervised by Japanese specialists at the expense of the Chinese Petroleum Corporation for about four months. When Japanese seismologists left Taiwan the seismic survey was carried out by CPC personnel. One seismologist was sent to Taiwan from the United Nations in a supervisory capacity to assist and supervise the seismic work in 1957. In addition a second seismic party was also established in 1957, and two sets of gravity meters were bought for assisting in the field work in 1959. The Geological department of CPC has been strengthened with micropaleontologic research and sedimentological study in 1955 and 1957 respectively. Photogeology is another instrumentation occasionally to be used in assisting, mapping geologic structure which may be favourable for trapping liquid or gaseous hydrocarbons. Photogeology is to be used in experimental stage.

RESERVE OF OIL AND NATURAL GAS IN TAIWAN

10. As mentioned in the previous Article most of the present producing fields are producing at a declining rate. It is hard to estimate the more reliable reserves of those old fields due to lack of usable data and information. However, the reserve of the newly discovered zones of Chinshui field can be calculated in more reasonable figures based on the available data obtained recently. Other structures are in an exploratory stage, so we feel it may be premature to make estimates of owing to the insufficient geologic and geophysical information available.

	Proved Reserve		Probable Reserve-	
	Crude Oil	Natural Gas	Crude Oil	Natural Gas
	kl	m3	kl	m3
Chinshui	3,832,900	19,495,000,000	5,710,000	34,020,000,000
Chuhuangheng	13,600	42,300,000	400,000	1,200,000,000
Chutung	---	29,900;000	---	128,000,000
Shantzechiao	1,500	200,000	100,000	13,000,000
Niushan	---	37,500,000	---	200,000,000
Chutouchi	680	23,800,000	300,000	132,000,000
Total:	3,848,680	19,628,700,000	6,510,000	35;693,000,000

The proved reserves of some old fields seem rather meagre in quantity, but the potentialities of some other structures are recognized to be very promising, quantitative figures may be given later.

Present Development

11. Chinshui Gas Field

(a) The Chinshui field is an anticlinal structure, the dips of both flanks are about 10-30 degrees, the eastern flank is slightly steeper, the rocks cropping out at the surface are Pliocene in age. There are 21 producing zones so far penetrated in the Miocene formations. At the northern part of the structure shallower zones have been developed and have been producing for about 50 years. However, at the middle and the southern parts which are now proved to be structurally high and prolific portions had not been tested and developed until 1960. Since the discovery of deeper pools of gas reserves from the deepening of well 38 in the Chinshui field in 1959, some exploratory wells have been drilled in the middle and southern parts of the anticline, and a tremendous quantity reserve of gas has been proved in Zone 13 and others. A major part of the Chinshui anticline has proved to be productive, especially zone 13 has been recognized as the most profitable and easy to reach (2,500 m. deep) the productive sand. Now there are four wells, two completed in 1960 and two completed in 1961, spaced at about 1,000 meters, available to produce from this zone. The average daily production of each of these wells is about 80,000 cubic meters of natural gas through 1/4 choke. Some crude oil associated with gas is produced, the ratio ranging from 1:20,000 (1 kl crude oil to 20,000 m3 gas) to 1:10,000.

(b) The deeper zones, 17 through 21, have been proved prolificly as evidenced by the drilling records of wells 38 and 52, which are spaced at 2.3 km distance. Well 38 could produce at least 100,000 m3 day from zones 17A and 18 at steady flow through double-choke. The bottom hole pressure of these two zones is reported approximately 7,3000 psi. Well 52 was completed at zone 20 and with a flow of 110,000 m3 natural gas and 4.5 kl crude per day through 1/2" choke by productivity test.

(c) It is scheduled to drill a total of 18 deep wells and 10 shallow wells for developing the deep and shallow horizons of this field. The production target has been set, at 1,500,000 cubic meters of gas per day after the completion of these wells.

Chuhuangkeng Oil and Gas Field

(a) The oldest producing field in Taiwan, Chuhuangkeng anticline, is situated at 17 kilometers south-east of the Miaoli city. The very prominent ropographic and geologic expression of the spindle shaped anticline shows its axis trending approximately NNE for a traceable length of about 25 kilometers, with a width of only 5 kilometers. Formerly 105 wells had been drilled along the west flank of the southern culmination. The total production of crude oil is about 220,000 kiloliters and of the natural gas more than 100,000 cubic meters. In the latter part of 60 years production history, it has declined to such a stage of depletion that only 23 wells remain producing with an insignificant amount.

(b) The flanks of the anticline are very steep. At the axial portion, the middle Miocene, Chuhuangkeng formation is exposed and a dip-slip fault developed along the axial direction which formed a curved fault surface that might have slipped along the eastern dipped bedding plane at depth.

(c) Based on the restudy of the geology of the anticline, structural sections and structural contour maps of the deeper horizons of the lower Miocene in the anticline have been made so that a deep well was decided to be drilled on the eastern flank and to the east side of the major dip slip fault. The total depth of the test well No. 106 is 3,561.60 meters so that the lower Miocene, Nushan formation for the first time has been encountered. The dips shown by the well-bore are nearly vertical close to the surface, and gradually become gentle, about 300 below the depth of 3,000 meters. This indicates the structure of a tightly folded anticline near the surface probably becoming gentler toward the depth.

(d) The newly discovered five gas zones in this well are within the depth range of 2,889-3,561 meters, which belongs to the lower Miocene Nushan formation. The producing zones are very tight sand, but the gas production estimated from the formation test might reach 80,000 cugic meters per day. The shut-in bottom hole pressure from the same test was around 4,000-6,000 psi. Chemical analysis of the natural gas produced shows 40% of CO2 and 60% of methane.

(e) The result of this deeper pool test in Chuhuangkeng structure has the significance that,

(i) The productive Meshan Formation has an extensive distribution in the deeper part of the structure, therefore many development wells should be drilled afterwards.

(ii) A wide distribution of Mushan Formation containing good reservoir sands and possible reserves of hydrocarbon exists in northern Taiwan. Deeper drilling of the favourable structure is necessary even if the shallower reservoirs were not productive by former drilling tests.

(iii) The Wuchishan Formation, a very good reservoir sand exposed at some places in the northern part of Taiwan underlies the Mushan Formation and has not been reached by No. 106. A little oil production has been found from this formation in the wells of the Shantzechiao structure. It is suggested that further deep drilling shall set its deeper target in the Wuchihshan formation in the expectation of production in addition to that of the Mushan formation.

(iv) The production test of the No. 106 well is mainly gas with only a very small amount of light crude and we are not certain now where the location of the well is in regard to the gas-oil contact.

Further tests should emphasize on this relation for the prearrangement of the reservoir energy maintenance of the production efficiency.

Present Utilization of Natural Gas and Crude Oil.

13. Natural Gas

(a) By using the natural gas newly discovered and produced from the Chinshui field as feeding stock and fuel, the projected area plant will produce 100,000 metric tons of urea and 45,000 tons of ammonia annually. With this 45,000 metric tons of ammonia, an additional 50,000 metric tons of urea and 160,000 metric tons of ammonia sulfate 30,000 tons of nitric phosphate will be manufactured annually in other fertilizer plants. It will directly benefit a great deal agriculture, and indirectly promote the economic development of Taiwan.

(b) Natural gas produced from the existing field is being used for fuel and raw material of industries and domestic fuels as well. It is anticipated such markets as well as the market for petrochemicals will be increased with the increasing of gas production in the days to come.

The United Nations' Assistance in the Field of Petroleum Resources Development in Taiwan, China

The government of the Republic of China appreciates very much the United Nations technical assistance on petroleum exploration. The petroleum experts such as petroleum geologists, seismologists and micropaleontologist assigned to Taiwan, Republic of China, have benefited a great deal from the petroleum prospectings.

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